Provisional Application For Patent Cover Sheet

Address to:
Assistant Commissioner for Patents
Box Provisional Application
Washington, DC 20231

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 C.F.R. § 1.53(c).

Docket Number: 36719:~~168845~~ 166845	Type a plus sign (+) inside this box ☞	+

INVENTOR(S)/APPLICANT(S)			
Last Name	First Name	Middle Initial	Residence (City and either State or Foreign Country)
1) DIEPOLD	Klaus	-	Siegertsbrunn, GERMANY

TITLE OF THE INVENTION (280 Characters Maximum)

Method for the Graphical Representation of Motion in Video in Still Images

CORRESPONDENCE ADDRESS (including country if not United States)

VENABLE
P. O. BOX 34385

State: Washington, DC Zip Code: 20045-9998 Country: US

ENCLOSED APPLICATION PARTS (*check all that apply*)

☒ Specification & Drawings *Number of pages*: 6 ☒ Small Entity Statement
☐ Other (specify) _____

Method Of Payment (*check one*)

☒	Our check is enclosed to cover the Provisional filing fees.	Provisional Filing Fee Amount ($)	
☒	The U.S. Patent and Trademark Office is hereby authorized to charge any deficiencies in the filing fees and credit any overpayments to Deposit Account No.22-0261. A duplicate copy of this sheet is enclosed.	$75.00	
☐	The U.S. Patent and Trademark Office is hereby authorized to charge any fee associated with this filing to Deposit Account No. 22-0261		

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No
☐ Yes, the name of the U.S. Government agency and the Government contract number are:

_____

Respectfully submitted,

Signature: Richard L. Aitken Date: Oct 10, 2000
Typed or Printed Name: Richard L. Aitken Registration No. 18,791
(*if appropriate*)

☐ Additional inventors are being named on separately numbered sheets attached hereto.

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

Applicant or Patentee: Klaus Diepold. Attorney Docket: 36719:166845
Application or Patent No.: To be assigned
Filed or Issued: Herewith
For: METHOD FOR THE GRAPHICAL REPRESENTATION OF MOTION IN VIDEO IN STILL IMAGES

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS
(37 CFR 1.9(f) and 1.27(c)) - SMALL BUSINESS CONCERN

I hereby declare that I am
[ ] the owner of the small business concern identified below;
[ ] an official of the small business concern empowered to act on behalf of the concern identified below:
NAME OF CONCERN: DYNAPEL SYSTEMS, INC.

ADDRESS OF CONCERN: 380 Lexington Avenue, Suite 4500, New York, New York 10168-1495

I hereby declare that the above-identified small business concern qualifies as a small business concern as defined in 12 C.F.R. §§ 121.3-18, and reproduced in 37 C.F.R. § 1.9(d), for purposes of paying reduced fees under sections 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the fiscal year of the concern of the persons employed on a full-time, part-time, or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other, either directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention, entitled METHOD FOR THE GRAPHICAL REPRESENTATION OF MOTION IN VIDEO IN STILL IMAGES inventor(s) Klaus Diepold described in

[x] the specification filed herewith
[ ] Application filed
[ ] Patent No._____, issued _____

If the rights held by the above-identified small business concern are not exclusive, each individual, concern, or organization having rights to the invention is listed below* and no rights to the invention are held by any person, other than the inventor, who could not qualify as an independent inventor under 37 C.F.R. § 1.9(c) or by any concern which would not qualify as a small business concern under 37 C.F.R. § 1.9(d) or a nonprofit organization under 37 C.F.R. § 1.9(e). *NOTE: Separate verified statements are required from each named person, concern, or organization having rights to the invention averring to their status as small entities. 37 C.F.R. § 1.27.

NAME_____
ADDRESS_____
[ ] INDIVIDUAL [ ] SMALL BUSINESS CONCERN [ ] NONPROFIT ORGANIZATION

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. 37 C.F.R. § 1.28(b).

I hereby declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

SIGNATURE _____ DATE 8/10, 2000, 2000

NAME OF PERSON SIGNING: Richard L. Aitken, Registration No. 18,791
TITLE OF PERSON OTHER THAN OWNER: Attorney for DynaPel Systems, Inc.
ADDRESS OF PERSON SIGNING: 1201 New York Avenue, N.W. Washington, D.C. 20005

Method for the graphical representation of motion in video in still images

The motion of objects in a video clip is not represented in individual still images. We may use motion blurring to simulate a real-world camera in the presence of moving objects.

Motion-blur costs a great deal of rendering time, and it only blurs the objects so that their contours are unrecognizable. The goal is, to convey information about the movement of objects in a still image. To accomplish this goal, illustrative techniques from comics may be adopted to depict past and future motions of objects in a single image.

Representing Motion:

Speedlines are an important stylistic element in comics, and although they are not based on an exact physical model, their use is well known. Other means of depicting motion in still images include motion arrows and contour repetitions. Examples are shown in Figure 1 and Figure 2. In the latter case, earlier positions of an object are drawn with less detail or slightly faded, whereas the current state of the object is presented in all detail.

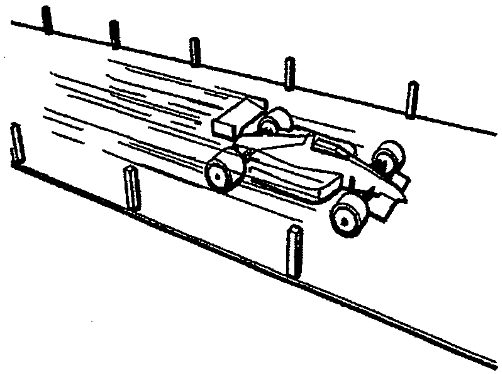

Figure 1: Example to illustrate the use of speedlines for representing motion in line drawings

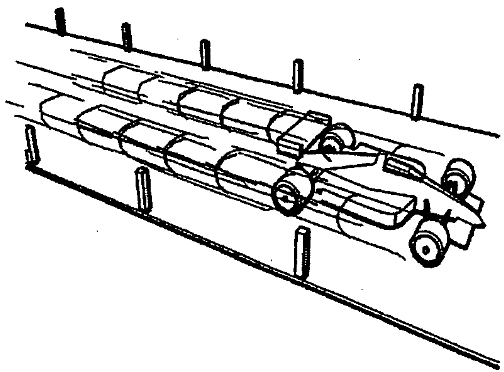

Figure 2: Example to illustrate the combined use of speedlines and contour repetition for representation of motion in line drawings.

Generating Speedlines, Contours, and Arrows

For an automated generation of speedlines, arrows, and contour repetitions, the motion information must be extracted from a given video. After executing a motion estimation process, we use the resulting 2D motion vector information in order to establish the location and the approximate shape of the moving objects. The information of motion, shape and location of objects is then used to establish the appropriate visibility and the perspective correctness of the speedlines. We have to keep track of the contour of every single object. We then calculate a motion path from the given keyframe data.

Human artists invented these graphic motion representations; their generation requires some heuristics about where and how to draw them. In general, speedlines and contour lines

- Are drawn in the opposite direction of the movement;
- Start at "characteristic" points of the moving object;
- Embrace the minimum and maximum extent of the object;
- Are more or less equally sized, shaped, and directed, without intersecting each other;
- Are uniformly, but not too regularly distributed.

Candidates for starting points of speedlines are extreme points lying on the object boundary, which yield the outline of the object. The algorithm divides the shape into a number of stripes where each stripe can hold one speedline. If a stripe contains no such key point, additional points are generated on the object's outline. In addition, the speedlines should not stick to an object: the algorithm should draw them with an offset.

Drawing Lines with Style

The output of the renderer consists of an image which has overlayed the speedlines. The lines are drawn using line styles, which, in turn, simulate hand-drawn pen-strokes, by the superposition of the drawing path and the chosen line style.

In order to achieve an appealing end result little user interaction is necessary, since nearly all speedline parameters can be computed based on the data based on the estimated motion information. Therefore, length, width, distribution, number, etc. are determined by applying given heuristic rules for artistic expression.

Example

Figure 3 shows countour repitition applied to a keyframe taken out of a video clip. We have chosen to render a quite simple contour repetition result. In Figure 4, the motion vectors that have been extracted from the given video frames are overlayed on a key frame. In Figure 5, the mask is shown that contains the information about location and shape of the moving object.

Within the video source a scene may be chosen. This can be accomplished either by user interaction or by means of an automatic scene cut detection machnism. It may also be a combination of both options, i.e., the automatic mechanism makes a proposal, which may be adopted or overruled and edited by the user.

In the next step a key frame needs to be selected. The key frame serves as the basis for the next stage where motion will be estimated and it is also considered as the image into which the graphic motion representation will be finally inserted. Again, this step can be performed either fully automatically, completely manual or semi-automatically.

The selected key frame along with the other frames in the selected scene are fed into the motion estimator that extracts motion information throughout the sequence with respect to the selected key frame. The motion information may be in the form of dense motion vector fields and may be determined as described in the copending application entitled System For Estimating Optical Flow, filed June 14, 2000, which application is hereby incorporated by reference. The resulting raw motion information may be separated into camera motion and object motion.

In the next stage, for the graphic motion representation not representing camera motion but object motion, the video clip and the motion information will be compensated for the extracted camera motion. The result is video clip and motion information that contains information about the moving objects.

The cleaned motion information along with the video frames are then processed in order to find the location and the approximate shape of moving objects. The detected moving objects will then be presented to the user by means of highlighting the pertaining pixels. The user is then able to select the object or the objects for which graphic motion representation shall be applied. The user has the possibility to overrule the automatic extraction process by means of a manual interaction. The result of this operation is the object mask for the moving object.

After the objects are selected the user needs to specify what style shall be used for the graphic motion representation. Choices may be speedlines, contour repetition or a combination of both, or other types of graphic motion representation. This also includes the adjustment of parameters for the generation of the graphic motion representation, such as line type or line density. More information on artistic features of graphic motion representation may be found in the corresponding literature.

With the information gathered so far the system will render the key frame along with the speedlines into a new still image. This image is displayed to the user for approval. If the result is approved, the rendered image is stored and the operation is finished. If the result is not approved, the user has the choice to jump back to either the selection of the key frame or the selection of the detected

objects. Other possibilities to modify the design decisions can be implemented also.

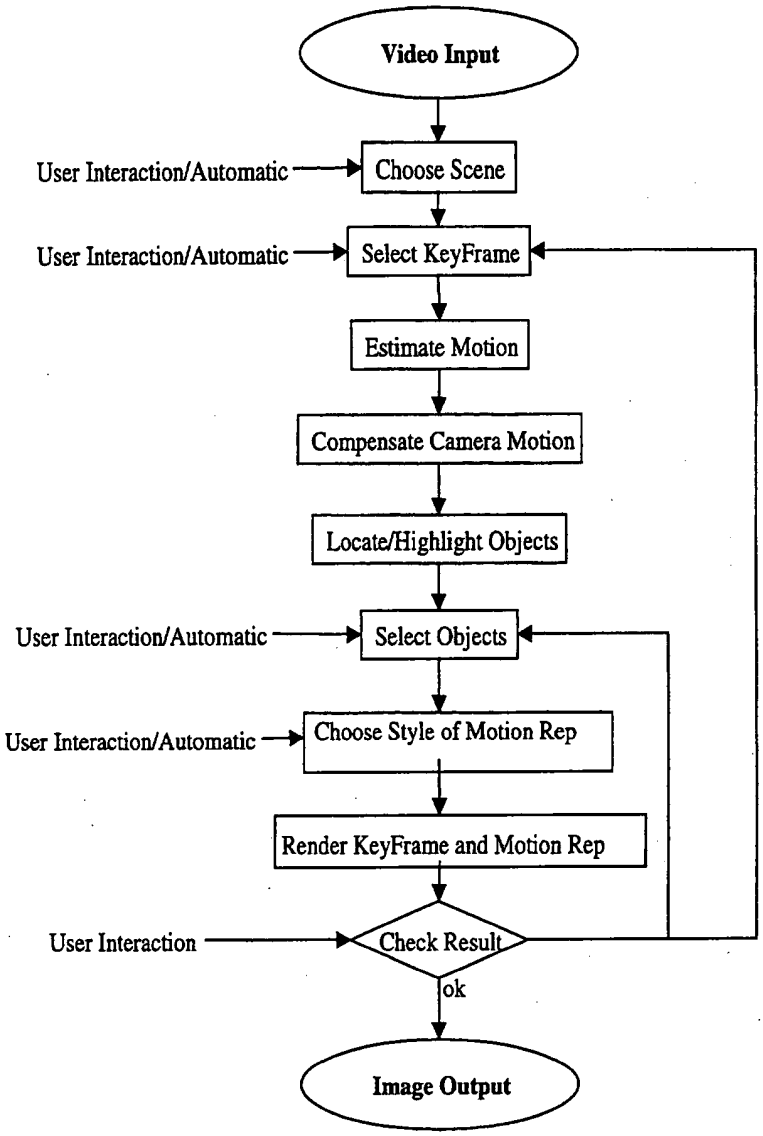

Figure 6: Flow Diagram of Speedline System

Claims

- The combination of estimating dense motion vector fields, camera motion and object segmentation for the generation of speedlines.
- Application of the concept of speedlines as a graphical overlay applied to natural video frames in order to represent motion in video for very low bandwidth transmission systems;

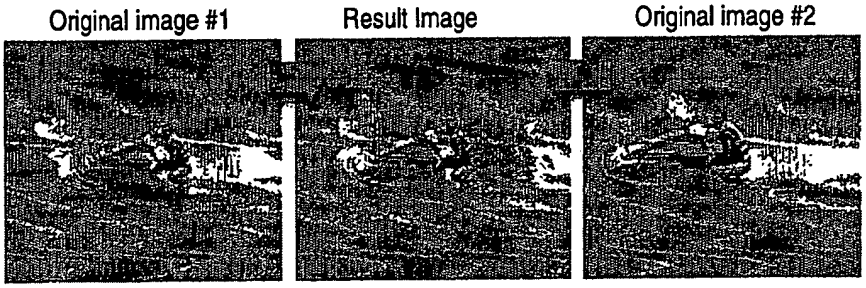

Figure 3: Illustration of the effect of representing motion in video by means of a still image and countour repitition.

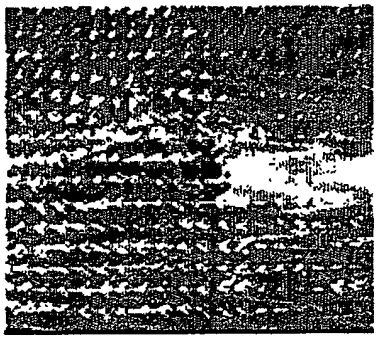

Figure 4: Motion vectors extracted from the video frames, overlayed on a key frame.

Figure 5: The mask extracted from the motion data for the generation of contour repition or speedlines.

Description of the system

In Figure 6, the flow diagram of the system for the semi-automatic generation of graphic motion representation enriched still images is depicted.

A video source is the input to the system.